In Cabin Driver Health Monitoring and Automated Emergency Response System

Tejas Shinde[1], Snehal Pawar[2], Krutika Shinde[3], Sakshi Takale[4], Prof. Harshal Muley[5]
[1,2,3,4]*Department of Electrical Engineering Zeal College of Engineering and Research, Pune*
[5]*Guide, Assistant Professor, Zeal College of Engineering and Research, Pune*

***Abstract*—The project involves the development of a comprehensive In-Cabin Health Monitoring System with Automated Emergency Response, utilizing ESP32. The aim is to provide a proactive approach to driver well-being and safety by continuously tracking health parameters and integrating automated vehicle response mechanisms. The system takes in real-time physiological data through a pulse oximeter for blood oxygen saturation and heart rate, a glucose sensor for blood sugar level, and a temperature sensor. The data is read by the ESP32, which is programmed to monitor and analyze the data against preset limits to identify any health abnormalities.**

In the event of detection of any life threatening or anomalous condition, the system will automatically activate safety mechanisms which include turn on a warning buzzer and hazard lights to alert adjacent drivers and passengers of possible life-threatening emergency. Also, it will turn on the auto-parking feature to guide the vehicle to a safe stop thereby avoiding accidents due to driver incapacitation. The system will also utilize GPS to locate the vehicle and Blynk mobile application to inform the caregiver or emergency contact of the critical condition and location of the vehicle. These alerts will contain detailed information concerning the condition of the vehicle and the vehicle location and help to locate and transport the driver to the nearest hospital as quick as possible to prevent casualties of the critical condition.

I. INTRODUCTION

Many accidents on roads occur due to the sudden health issues faced by the driver like heart attack, low blood sugar level, fever, fatigue or any other health emergency. These problems and health issues may result in loss of concentration and loss of time for reaction which may result in a damage to the vehicle. Hence, to solve this problem a smart driver health monitoring system can be built using the Internet of Things technology. This project is based on an ESP32 microcontroller that monitors the vital health parameters of the driver like pulse, body temperature and glucose level in real time through sensors.

In any abnormal state being found, safety behaviors are promptly taken by the system. It issuing warning to the driver, this may be led to by a buzzer or display, by glare lights, and can assist in bringing the vehicle to a safe stop. Meanwhile, the ESP32 sends an emergency message along with the vehicle GPS location to the designated family members or close-by hospital via Internet, so as to provide prompt medical help and prevent possible accident. The system is beneficial to enhance the safety of road, to cut down the fatality rate, and to upgrade vehicle health-state monitoring system to an intelligent one system to an intelligent one. fatality rate, and to upgrade vehicle health-state monitoring system to an intelligent one.

1.1. Objective

The main goal of this project is to develop an IoT based driver health monitoring system which can continuously monitor driver's health during driving. In the smart system, essential health parameters like pulse rate (BPM), temperature and blood glucose are monitored using smart sensors at regular interval and used to recognize the driver's condition at any instant. It will allow any driver's illness to be detected early.

The second important objective is to provide immediate alert to the driver on any abnormal health condition. If abnormal health parameters are detected then the Buzzer is switched ON to alert the driver instantly. An immediate alert allows the driver to cope with the situation before it worsens.

Third important objective of this project is to enhance vehicle safety during the time of any emergency situation. It activates hazards light and a rudimentary auto-parking system at the time of emergency to secure the vehicle's control as driver is unable to manage in such situation.

Fourth important objective is to make monitoring more efficient and reliable by relaying live health parameters and notification to the Mobile Application where family members or any authorized person will be able to keep check of the drivers' condition in real time from any location.

The final and an important objective is to accelerate emergency response. Using GPS, the vehicle's current location along with emergency notification are sent to the registered contacts and the hospitals.

II. LITERATURE REVIEW

The reviewed research papers collectively focus on enhancing road safety by using Artificial Intelligence (AI) and intelligent monitoring systems to analyze driver behavior and health conditions in real time. A common theme across all studies is the detection of unsafe driving patterns such as drowsiness, fatigue, distraction, and aggressive driving, which are major causes of road accidents.

These systems typically collect data using in-vehicle cameras and sensors that monitor both the driver and the vehicle environment. Some approaches also include health-related monitoring to identify early signs of medical issues that may affect driving performance. This combination of behavioral and physiological data helps in improving the accuracy of accident prediction and prevention systems.

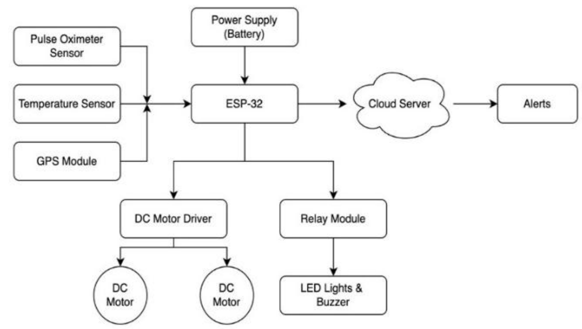
To process the collected data, various advanced techniques are used, including image processing, signal processing, machine learning, and deep learning. Some studies further improve performance by using attention-based deep learning models and intelligent algorithms to detect subtle changes in driver behavior more effectively.

Additionally, one of the approaches explores health-related intervention systems that can respond to abnormal conditions through alerts and interactive assistance, while another study highlights advanced monitoring techniques for intelligent transportation systems.

Overall, all the reviewed works aim to reduce road accidents and improve driving safety by enabling early detection of risky situations and providing timely warnings or interventions. They emphasize the importance of combining AI, sensor technology, and real-time monitoring to develop smarter and more reliable transportation systems.

III. METHODOLOGY

Block diagram



ESP-32:

The ESP-32 is the microcontroller of the entire system. The inputs received by the ESP-32 are from the pulse oximeter sensor, temperature sensor and GPS module. After the calculations, it controls the various outputs, such as the relay module, motor driver, LED light, and buzzer. It also sends the real time data to the cloud server through the Wi-Fi available in the ESP-32 itself. It is generally used in IOT as it has high processing speed, less power consumption and easy to communicate with through Wi-Fi.

Pulse Oximeter Sensor:

The pulse oximeter sensor is a finger sensor that uses a light of infrared and red color for measuring the heart rate and the amount of oxygen saturation in the driver's blood (SpO). The sensors continuously provide with the condition of the driver's health to the ESP-32, and also provides with an alarm or safety function to be executed when the heart rate or oxygen level falls out of range.

Temperature Sensor:

The body temperature of the driver is measured by temperature sensor. It uses to detect fever, over heating of body, unusual body temperature conditions that cause for safe drive. The sensor converts temperature in to electrical signals and send it to ESP-32. DS18B20 sensors were used for this because they are more accurate and easier to interface.

GPS Module:
The GPS module is used to send the real-time geographical location of the vehicle. The GPS module uses signals transmitted from satellites to identify the vehicle's coordinates (latitude, longitude). When an emergency occurs, the GPS coordinates will be transmitted to the cloud server or emergency contact to locate the vehicle

Cloud Server:
The cloud server has been responsible for storing, controlling and monitoring the received data. The data (health and vehicle data) is being transmitted via the internet by the ESP-32 to the cloud server. Users can also view the data from the mobile/computer and run the real time IoT monitoring applications with the history of data collected

Alert System:
When the system detects an abnormal condition of the driver's health, it will send a warning signal. The system will be able to send warnings to blink IoT, or to notifications provided by the cloud service. Furthermore, the system can trigger alarms on local devices such as buzzers.

Relay Module:
The relay acts as a switch which operates based on electricity from the ESP-32. Because it is not possible for the microcontroller to work with high voltage power, the relay ensures isolation and safety in its switching operations. It is used to switch ON and OFF devices like LED lights, buzzers, and security systems of a vehicle.

LED Lights and Buzzer:
The LED lights and buzzer will be helpful in creating visual and auditory cues during emergencies. Once the system senses any irregularities in the health parameters, it will turn on the LEDs and buzzers to create alert sounds. The alerts can help in drawing attention and notifying other people or vehicles present at the location.

DC Motor Driver:
The DC motor driver is an interface circuit between the ESP-32 and the DC motors. Since the ESP-32 cannot supply sufficient current to run motors directly, the motor driver amplifies the control signals. It controls the speed and direction of motor rotation using commands from the microcontroller. Motor drivers such as L298N are used in vehicle prototype systems.

Power Supply:
The power supply delivers electricity to all parts of the system. Rechargeable batteries like lithium-ion batteries are used since they ensure portability. Power supply delivers stable voltage to sensors, ESP-32, relay module, motor driver, and motors. Efficient power management is key for system reliability.

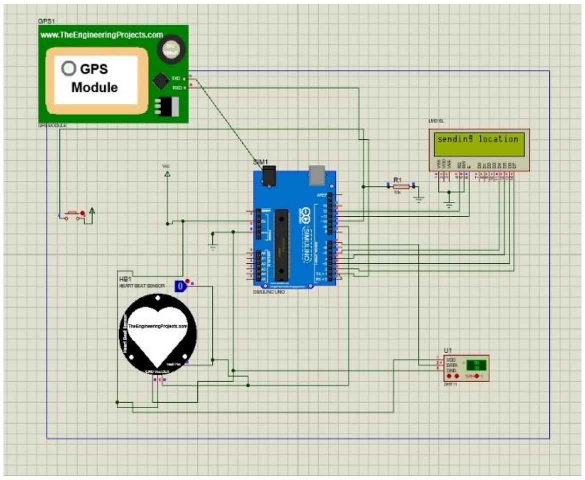
Working:
This system has been titled "In-Cabin Driver Health Monitoring and Automated Emergency Response System." It has been designed to increase the safety of a vehicle through monitoring the health status of the driver, as well as responding during emergencies. An ESP32 microcontroller forms the basis of this system by acting as the processor of all activities.

There will be several components in the operation of this system such as the pulse oximeter sensor, temperature sensor, GPS module, DC motor driver, relay module, cloud server, and alert system. All the devices used will be powered by a rechargeable battery. The pulse oximeter sensor will monitor the pulse rate and the oxygen level, while the temperature sensor will monitor body temperature. These values are then transmitted to the ESP32 microcontroller.

Under normal circumstances, the ESP32 controller will control the smooth working of the DC motor driver, hence the working of DC motors. Additionally, the GPS module will provide tracking of the live location of the vehicle and transmit coordinates to the ESP32. This data will then be stored remotely on the cloud server.

The ESP32 automatically initiates an alarm when any health anomalies including irregular heart rate, lack of oxygen, or increase in body temperature are detected, and activates the relay module that turns on the warning LEDs and the buzzer to inform people around the vehicle. In addition to this, the emergency message and GPS location are automatically sent to the concerned individuals through the cloud server.

This automatic process ensures that road accidents due to sudden health problems faced by drivers can be avoided. The proposed design is not only economical but also reliable and applicable in all types of vehicles imulation:



This is a driver's health and location monitoring circuit using Arduino platform and Internet of things technology, with the help of different kinds of sensors and communication tools to ensure that the driver's safety is monitored in real time. Arduino UNO is going to act as the controller in this system, where it will be responsible for gathering information from all sensors, processing and deciding upon them based on certain threshold values.The GPS module will provide real-time geographical coordinates (latitude and longitude) of the vehicle at any instant of time.The heart beat sensor (HB1) is being used to monitor the pulse of the driver. Any abnormality in heart rate is to be treated as a health hazard. The DHT11 sensor is going to monitor the environmental temperature and humidity, through which the tiredness level of the driver can be calculated.

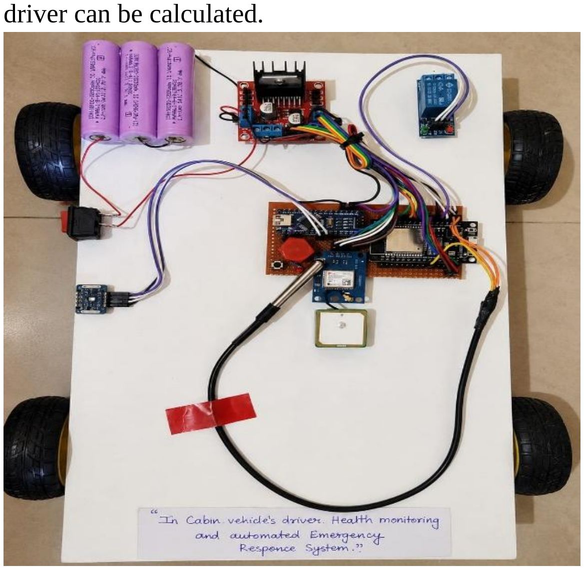


Fig -1: In Cabin Driver Health Monitoring and Automated Emergency Response System

The Above Model is a Driver Health Monitoring & Automated Emergency response system, the hardware components are ESP32, GPS module, sensors, relay module, motor driver. It constantly monitors driver's health and vehicle location, and upon detection of abnormality sends an alert and location details to specific contacts via the controller. It aims at making the driver's health and the vehicle alert.

Table -1: IOT Interface Using Blynk

Parameter	Value	Status
Heart Rate	69 BPM	Normal
SPO2	95%	Normal
Temperature	36.12	Normal
Glucose	105.85	Normal

In this project, we are continuously monitoring the physical parameters to determine the health of a person. The standard heart rate for a healthy individual is 60-100 BPM (beats per minute), which determines whether the heart is working normally. The normal SPO2 level in a healthy person is 95-100%, which determines the oxygen supply in the blood of a healthy person. The normal body temperature is 36.5C-37.5C, which determines fever or abnormal body condition. Glucose is also monitored, where the normal fasting glucose in the body is 70-100mg/dL.

III. CONCLUSIONS

We Conclude that how the proposed “Driver Monitoring/Health Check- in and Emergency Alerting System” was able to monitor both driver health and location using the Internet of Things (IoT) concept; detect emergencies; and automatically send a message that includes both an alert and the GPS coordinates after detecting an emergency condition. This project has the potential to improve driver safety and provide a rapid response time in case of an emergency and therefore is a positive step toward creating a safer, smarter vehicle safety system.

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